INTERIM REPORT

on

INTEGRATED AGRICULTURAL DEVELOPMENT PROJECTS

in

CANAL IRRIGATED AREAS

by

The Task Force on Integrated Rural Development

PLANNING COMMISSON

GOVERNMENT OF INDIA

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CHAPTER 1

INTRODUCTION

1.1. In October, 1971, the Planning Commission appointed the Task Force on Integrated Rural Development. The composition of the Task Force was initially as follows :

1. Dr. B.S. Minhas, Member, Planning Commission.	-Chairman
2. Shri M. Ramakrishnayya, Addl. Secretary, Department of Community Development.	-Member
3. Financial Adviser, Ministry of Agriculture.	-Member
4. Shri N.G. Abhyankar, Development Commissioner, Govt. of Maharashtra.	-Member
5. Shri G.V.K. Rao, Development Commissioner, Govt. of Mysore.	-Member
6. Shri M.J. Bhutt, Director, Industrial Dev. Services, (P) Ltd., New Delhi.	-Member
7. Shri Ranjit Gupta, Research Director, AVARD, New Delhi.	-Member
8. Shri S.V. Govindarajan, Chief Soil Survey Officer, IARI, New Delhi.	-Member
9. Shri Anand Sarup, Chief (SP) Planning Commission. [now JS(SP)].	-Member
10. Dr. A. Vaidyanathan, Director (PP), Planning Commission. (now Chief PEO).	-Member
11. Shri S.S. Puri, Jt. Secretary, Planning Commission.	-Member Secretary

1.2. Subsequently, on retirement of Shri S. V. Govindarajan, his successor, Dr. R. S. Murthi, was appointed as Member of the Task Force. The following Members were also added.

1. Shri M. A. Quraishi, now Special Secretary, Ministry of Agriculture.

2. Shri B. B. Vohra, Joint Secretary, Ministry of Agriculture.

1.3. The Terms of Reference of the Task Force are as follows :

(i) To spell out the main elements of a broad strategy of integrated rural development oriented towards more employment and better production be in the Fifth Five Year Plan;

(ii) To work out illustratively the pattern of technology, investments, and institutions for rural development programmes appropriate to different agro-climatic conditions and levels of development;

(iii) To review in the light of (i) and (ii) above the on-going special programmes for rural development and rural employment and to suggest ways for their modification and synthesis into an integrated programme of rural development.

Meetings and Tours

1.4. Some of the members of the Task Force had an informal meeting prior to the formal constitution of the Task Force. The first formal meeting of the Task Force was held on 29th January, 1972. This was followed by a second meeting on 29th May, 1972. In the meantime, the members of the Task Force undertook the following tours :

(i) Tour of Command Area of Chambal Project near Kota in February, 1972.

(ii) Tour of Etawah District and Visit to Pilot Development Projects in March, 1972.

(iii) Tour to Indo-German Integrated Agricultural Development Project, Mandi District in April, 1972.

1.5. In the course of the tours, the members of the Task Force had occasion to visit areas where one or more experiments aiming at integrated rural development had been undertaken. Members of the Task Force also had detailed discussion with Commissioner, Chambal Command Area, the Project Officer and other concerned officers from the project as well as the district. In Kota, discussions were also held with the UNDP personnel working on the project. A similar pattern was repeated at Etawah as well as at Mandi.

Scope of the Interim Report

1.6. The order constituting the Task Force had visualised that it may furnish an interim report so that, in the light of such report, action may be taken to initiate some projects during the remaining period of the Fourth Plan itself. This interim report is being furnished in pursuance of this requirement.

1.7. According to the terms of reference, the Task Force is required to work out illustratively the pattern of investment and institutions for rural development programmes appropriate to different conditions and levels of development. In this interim report, we are confining ourselves exclusively to one land and water resource situation, namely, areas where canal irrigation has been introduced or is proposed to be introduced and where integrated land and water development appears essential for optimum development of irrigated agriculture.

Acknowledgements

1.8. We would like to place on record our thanks to various State Governments, organisations and various officers who assisted us by providing us with valuable information and experience in the course of our tours. Our gratitude is specially due to Shri U. S. Badal Project Officer, Soil and Water Management Project. Kota and his team of Indian and UNDP officers whose work has provided us largely with the basic source material for our report.

CHAPTER II

GENERAL APPROACH

Concept of Integrated Rural Development

2.1. Of late, it has not been uncommon to come across the phrase "integrated rural development". This phrase, however, is seldom used in the same sense. Sometimes it is applied in the context of integrated development of a whole region. On the other hand, it is also applied in relation to a very small area, say, 100 hectares. Thus the unit for integrated area development is varyingly conceived. Similarly, the phrase "integrated rural development" is differently employed. It can be used to embrace both agricultural development and rural industrialisation. It is possible to impart an even wider meaning so as to include even items such as rural health services. In view of these different interpretations, it seems necessary that, in the first instance, we should spell the concept of integrated rural area development.

2.2. After careful consideration, we have belatedly decided to take what might be considered a rather restricted view of the expression "rural development". We have chosen to equite it with agricultural development in the widest sense so as to embrace, besides crop husbandry, all the allied activities. The integrated development that we visualise encompasses both spatial and functional integration of all relevant programme bearing on increased agricultural production and reduction of unemployment and under employment among Small Farmers and Agricultural Labour.

2.3. In our view, the unit for planning of integrated development should comprise an area (falling within a district) which has a substantial measure of homogeneity in terms of land and water resource situation. This homogeneity is evidently necessary to ensure that there are certain common types of works and programmes that need to be undertaken in a proper sequence in order to exploit the development potential of the area and also to extend the benefits of such development to the mass of the people in that area. In this context, it is possible to visualise

a variety of land and water resouree situations. For instance, there are areas whieh are endowed with eanal irrigation and a undulating topography. Again, there are areas whieh have eanal irrigation and wheie land surfaee is relatively even. Then there are areas where irrigation is principally derived from ground water. There are other areas which may be charaeterised either as dry farming areas or drought prone areas. Finally, there are hill areas. Eaeh of these eategories is eapable in turn of being subjected to more refined and sophisticated sub-divisions. However, from a praetical point of view, a broad identification of land and water resouree situation should suffiee.

2.4. There are two pre-eminent objeetives whieh are implieit in our eoneept of integrated rural development. These are :

(i) In a defined rural areas, realisation of the fullest agrieultural produetion potential must be attempted by mutually reinforcing measures connected with development of local land and water resources and the provision of all complementary production inputs and organisational improvements as also development of human skills.

(ii) The developments promoted in the defined rural area should be as broad-based as possible so that the large mass of the rural people particularly the small farmers, marginal farmers, agrieultural labourers are enabled to participate in development and share the benefits of such development.

2.5. There is at present a bewildering variety of programmes and schemes eonneeted with different aspects of rural development and employment. While, in many ways, these programmes and schemes are intended to be eomplementary in eharaeter, in practice they are often not eoordinated in a given area in a proper time sequenee. The developmental inter-aetion and coordination among these new sehemes is inadequate. Various rural development programmes and sehemes are still *ad hoc* in eharaeter and suffer from wide dispersal and fragmentation over different distriets/areas. This laek of a systematie synthesis of various programmes often results in over-lapping of finaneial and organisational resources. Another eonsequenee is the ineffeetiveness of the impact of developmental effort. The prineipal objective of the proposed integrated rural development projects will be to overcome these deficiencies.

Distinction from C.D. Block Concept

2.6. For the purpose of clarity it is necessary to distinguish the concept of integrated rural area development from the concept behind community development block. The latter was also conceived as essentially an area programme to promote Community awareness for better standard of living. However, on the agricultural side, it was focussed principally on providing to the farmer inputs and services external to the farm itself. Such inputs and services included extension, advice, seed, fertiliser, pesticides, implements and machinery, credit, marketing and storage. The Community Development Block programme did not specifically envisage any physical planning by way of reformation of land or re-organisation of water resources or diversification of investment to tackle the rural unemployment programme. Moreover, the Community Development Blocks were not identified on the basis of any homogenous land and water resource situation. The boundaries of the C. D. blocks were largely determined by administrative convenience. In the case of projects of integrated rural development, the objective is to refashion the productive apparatus of the rural economy of an area in terms of its land and water resources by undertaking measures such as consolidation of holdings, land shaping, re-alignment of water courses, construction of the drainage system and strengthening of other activities which are complementary to these programmes. This stress on detailed and careful physical planning on our part should not, however, be construed to mean that we are ignoring or deflating the importance of other elements such as C. D. concept of local participation in IADP concept of package practices.

Relationship with SFDA and MFAL

2.7. It seems necessary to bring out the relationship of integrated rural development project to the current SFDA and MFAL programmes. The latter programmes are, no doubt, area based. They, however, aim at improving the economy of the small and marginal farmers and agricultural labour in a somewhat segmental manner. In several cases, these projects happen to be located in areas which are suffering from a stagnant rural economy. Hence in such projects an effort towards optimum area development appears to be a condition precedent in improving the economy of small and marginal farmers and agricultural labourers residing in the project area.

CHAPTER III

RESUME OF SOME RELEVANT EXPERIMENTS

Etawah District

3.1. The Damodar Valley Corporation had undertaken a programme of soil conservation-cum-consolidation of holdings in the earlier part of 1950. This programme was studied in some details in 1957 by the Planning, Research and Action Institute of Uttar Pradesh. In the light of this study, in early 1958, an experimental project was undertaken in an area of 18 hectares in village Chirhulia of Ajitmal Block in Etawah District.

3.2. First of all, the area to be consolidated and conserved was identified and then the land thereof classified on the basis of fertility of soil in accordance with the instructions of the Consolidation of Holdings authorities. The land was divided into three classes; Type I, Type II and Type III. After making a topographical survey of the identified area, a contour map was prepared. On the basis of this map and valuation of soil on fertility basis, holdings were carved out after consolidating the scattered plots of different farmers at one or two places as far as possible. The layout of bunds along contour lands was indicated by the Project authorities, before their actual construction was taken up. The height of bunds was kept at about 2-1/4 ft. with a side slope of 1 : 1 and a cross-sectional area of 8.45 sq. ft. After construction of contour bunds, individual plots were demarcated and allotted to the farmers concerned, who put up their own field bunds, which too were attempted on the basis of sub-contours according to size, soil and slope of each plot.

3.3. Soil samples from three different classes of land as indicated above, were collected and got analysed through the Government Agriculture College, Kanpur. On the basis of soil analysis results, suitable recommendations for various agricultural operations and agronomical practices were made to the farmers in respect of their new 'chaks'. Besides construction of contour-bunds and sub-contour bunds, arrangements were also made for the drainage of surplus water to a nearby 'nallah'.

3.4. After taking over possession of newly formed 'chaks', the farmers grew their recommended crops. The crops in the Rabi of 1958-59 were very satisfactory as the farmers had adopted recommended cultural practices and rain-water had been conserved considerably on account of the presence of bunds. There was no damage due to water-logging as suitable arrangements had been made for the drainage of surplus water. The farmers were quite convinced about the efficacy of various measures in the very first year. They not only constructed their bunds, but also provided their own finance for construction of masonry works. However, a few farmers were given medium term 'taqavi' loans for *pucca* works construction. In all, 21 farmers were involved. The experience gained in village Chirhulia (Ajitmal Block) indicated :

(i) that integrated Soil Conservation and Consolidation of Holdings Programme could be carried out effectively in eroded lands, having gentle slopes,

(ii) that the farmers should be properly motivated and educated to evoke their active participation for consolidation and soil conservation operations on voluntary and self-help basis,

(iii) that technical guidance should be provided by duly trained V.L.Ws. and A.D.Os. (Soil Conservation) throughout the operation phase, and

(iv) that the consolidation staff should be closely associated with the Project staff while making re-alignment of land and distribution of 'chaks'.

3.5. The work in village Chirhulia was essentially of an exploratory nature. It provided very useful insight into the problems and prospects of integrated operations of consolidation of holdings and soil conservation and gave them good opportunity for practical training. The results achieved in the first three years, though of a modest nature, were promising. It was, therefore, decided to test the experiences gained on a limited basis by involving a large number of farmers over a larger area. For this purpose, a Pilot Phase of the Project was initiated in village Patia Chatorpur of Mahewa Block in the year 1962-63.

3.6. Actual area taken up under the Project was about 34 hectares with a gentle slope varying from 0.5 per cent to 1.6 per cent. All this area had been excluded from the consolidation of

holdings operations carried out in this village in the year, 1961-62. Other details of this area are as under :

(i)	Total area of the village	.. 93.4	hectares
(ii)	Net cultivated area of the village	.. 81.0	„
(iii)	Area excluded from the Consolidation of Holdings Operations	.. 33.90	„
(iv) (a)	Area taken under the Pilot Project	.. 33.90	„
(b)	Number plots in the Project area	... 1.03	„
(c)	Average size of plots	.. 0.33	„
(v) (a)	Total number of cultivating households in villages	.. 48	„
(b)	Households involved in the project	.. 38	„

From the above figures, it would be seen that about 40 per cent of the net cultivated area of the village was left out of consolidation of holding operations.

The Project area is located on the bank of river Sangar, having an average slope of 2.0 per cent towards the river. The soil of this area is predominantly sandy loan.

3.7. The significant features of Project planning and execution were as follows :

(1) A shajra map of the village was obtained from the Lekhpal for identifying the Project area and the particulars of individual holdings of the farmers.

(2) A topographical survey of the area was undertaken and a contour map was prepared.

(3) Thereafter, land classification was done on the basis of fertility of soil in consultation with revenue authorities and on the basis of this classification, the land was grouped into three categories, *viz.*, Type I, Type II and Type III. The classification was mainly based on the nature of soil and terrain.

(4) Demarcation of plots was done on the basis of contours marked on the shajra map and plots were generally aligned along the contours.

(5) While demarcating plots, sites of masonry escapes were also indicated.

(6) A detailed plan with estimates for construction of contour bunds and other engineering works, such as masonry escapes, drainage, etc., was prepared.

(7) Construction of contour bunds was taken up with the help of farmers/labourers and the expenditure thereon was provided by the authorities. Construction of masonry works was, however, got done at the cost of farmers in whose fields and for whose benefits such works were constructed. The work regarding levelling of individual plots was taken up by the farmers themselves with the help of levelling *karhas* driven by bullocks. No government expenditure was incurred on this account.

3.8. About 2.6 hectares unculturable waste land has been brought under cultivation. Further, there has been significant change in the area sown during Kharif. During the year 1962-63, only 50 per cent of the net sown area was under Kharif crops and the rest was left as monsoon fallow for conserving moisture for Rabi cultivation. The percentage of Kharif area increased to about 64 per cent in 1969-70. A small increase of 0.52 hectare was also registered in the area under Zaid crops, which were non-existent.

3.9. There has been a definite improvement in the cropping pattern of this area. In the base-year, during Kharif only rainfed crop of bajra and arhar was taken. The arhar crop, if its growth was good, was harvested in March/April. In case of poor growth for lack of moisture, it was used as a fodder for animals. Due to improvement in the moisture and soil of the area, the farmers have now started taking crops, like sugarcane, sweet potato and paddy. A significant increase in area has been registered under maize crop. Further, area under wheat has increased from 4.0 acres in 1962-63 to about 16 acres in 1970-71. Area under coarse grains, like bejhar (barley and gram) has declined and passed on to more remunerative crops, like wheat and potato.

3.10. As a result of the programme in village Patia-Chatorpur, the cultivators of adjoining villages of Sarai Ilahi, Indrausi and Kunetha have also taken up this programme in their villages under the technical guidance of soil conservation staff of Pilot Development Project. Of an area of about 296 hectares in these

three villages, an area or 181 hectares had been treated till the end of 1970-71. Contour bunds have been constructed by the farmers themselves at their own cost, after agreeing to voluntary exchange of 'chaks'. Necessary corrections in the revenue records have also been made in an area of 105 hectares in villages Sarai Lahi and Indrausi.

3.11. The average cost of normal soil conservation programme ranges between Rs. 100/160 per hectare and that of normal consolidation of holding operations from Rs. 35 to Rs. 60 per hectare. The limited experience of the present Project which has now been implemented in five villages in all, shows that combined operations can be carried out at a cost of Rs. 160 to Rs. 200 per hectare.

Chambal Command Area

3.12. Recently a few premising beginnings have been made in the direction of integrated rural development. In the Chambal Command Area in Rajasthan State, canal irrigation was introduced about ten years ago. In the absence of requisite measures for development of land, the potential benefit of irrigation remained substantially unutilised. In the absence of proper drainage arrangements, problems of soil salinity and water logging have emerged. In this background, an UNDP aided project for land and water development was initiated in Kota district. The project authorities, after necessary investigation and studies, took up a project for integrated development of land and water resources of a compact area in village Digod in Kota district. The aspects which were simultaneously covered by the project, were the following :

(i) Consolidation of holdings;

(ii) Land levelling;

(iii) Provision of drainage;

(iv) Training and clearing of nallahs;

(v) Re-alignment and lining of water courses;

(vi) Provision of structures on field water courses, irrigation canals and drainage ditches.

(vii) Farm paddy.

3.13. Since the above project was conceived as a demonstration, it was financed entirely by Government funds, However, as a result of the success of the demonstration, the concept behind the project began to catch the fancy of farmers. Recently a group of farmers have volunteered to come forward and obtain loans from Government and finance a similar development of their land and water resources in an integrated manner. This recent project which is of obvious significance, is located in Sunwasa village in Kota district, Nineteen farmers whose lands embrace the entire command area of an irrigation outlet from a minor distributory are the beneficiaries of this project. The total area covered is 72 acres. On an average, each farmer has taken a loan of about Rs. 1,500 per acre which is to be repaid in a period of 7-10 years. With the significant improvement on marketable surplus at the disposal of the concerned farmers, they are quite confident of repaying the loan out of their increased income. It may also be added that as a result of reorganisation and realignment of field boundaries, fields roads, water channels and drains, an area of about 5-10 per cent has been saved and added to the total cropped area.

3.14. The message behind the above project appears to have registered on the minds of the people. As a result, there is a growing demand in the Rajasthan part of Chambal command as well as in the Madhya Pradesh part of Chambal command for such reorganisation of land and water resources in an integrated manner. The State authorities of Rajasthan have negotiated a substantial loan of over Rs. 7.2 crores from six commercial banks. This would enable covering an area of about 45,000 acres for this kind of integrated treatment of soil and water. Concurrently, the authorities are also visualising intensification of extension effort and the arrangements for supply of credit, inputs etc. with a view to exploit the improved production potential of the land and water available in the concerned areas. It may be added that, according to latest report from project authorities, about 2,000 acres has been taken up for development by June, 1972.

CHAPTER IV

INTEGRATED AGRICULTURAL DEVELOPMENT PROJECTS IN CANAL IRRIGATED AREAS

Main Elements

4.1. For intergrated area development, it is not good enough to piece together a number of sectoral programmes operation in a given area. It is necessary that, while for implementation some disaggregation is inevitable, the initial project formulation must be on a comprehensive basis and must provide for all requisite elements bearing on the development of the resources of the area and the masses of the people residing in the area.

4.2. In a typical area served by canal irrigation, the following are likely to be some of the important elements which are relevant :

(i) Development of land and water resources

(ii) Consolidation of holdings

(iii) Crop planning and agricultural extension

(iv) Development of Infrastructure

(v) Development of Small Farmers and Agricultural Labour

(vi) Legislative and Administration framework

Development of Land and Water Resources

4.3. In each project, the detailed planning and implementation has to be on the basis of the Command area of a minor. The area within such command may further vary from 800 hectares to 4000 hectares. A part of such command area covering about 50-100 hectares can be taken up at a time for integrated land and water development. The main steps involved are :

(i) Survey and plotting

(ii) Planning

(iii) Land levelling and shaping

(iv) Construction of water courses

(v) Construction of drainage ditches

(vi) Construction of farm roads

(vii) Training of Nallahs

(viii) Development of minor irrigation facilities.

4.4. The listing above does not necessarily indicate the sequence of the various steps which will depend upon the situation obtaining in any particular project area. In fact, a number of operations may have to be taken up simultaneously to achieve the integrated land and water development. It must also be emphasised at the outset that responsibility for solution of the complex dynamic problems associated with integrated land and water development cannot be the prerogative of one or two disciplines and that closest cooperation between a large number of interested and qualified authorities is essential.

While details of the action require to be worked out for each specific area, a broad discussion of various factors is given below.

4.5. Topographical surveys showing contours at suitable intervals will be one of the essential pre-requisites for such projects. The exact contour intervals will, however, depend upon the physical characteristics of the countryside and the use to which these contour surveys are to be put. It can generally be stated that flatter the countryside, the smaller will be the contour interval, and *vice versa*. These contour surveys will help in land levelling, land shaping, laying out of water courses, field drainages, soil conservation bunds etc. While doing the topographical surveys, boundaries of farmers' holdings, Panchayat or Government lands, common wastes etc. may also be delineated.

4.6. Along with the topographical surveys, agro-economic and soil surveys need to be carried out to know the existing pattern of land utilisation and production levels. This will be useful *inter alia* for project formulation and also its evaluation when it gets going.

4.7. Having collected the basic data, the next step would be a design of the system wherein the various elements that enter into the integrated development of land and water resources have to be

defined; *e.g.* keeping in view the nature of the soil (infiltration rate etc.) climatic conditions and cropping patterns, the method most suited for providing irrigation to the fields is to be determined, whether it be border strip, furrows or sprinkler. The basic approach is to improve the efficiency of field application of water and reduction of application losses, as a result of wider appreciation of the physical characteristics of the soil. The design has also to take into account the timing, depth and uniformity of application. Excessive percolation beyond the root zone should be largely avoidable by matching the depth of each application with the available water storage capacity of the soil in the root zone of the crop at the time of irrigation. This requires some observation and knowledge of the moisture-holding capacity of the soil. Persistent over-irrigation not only gives rise to low water application efficiency but can also cause depression of yields as a result of leaching of soil nutrients and, if this practice is wide-spread, it may lead to waterlogging. Where excessive run-off is expected, a suitable system of field drains, collecting such excess waters, would need to be provided. Where field drainage is required to be provided, properly designed drainage inlet structures will have to be provided, in some situations, these may have to be designed to receive sub-soil drainage, especially where the soil are saline and where the water-table is high.

4.8. A common cause of reduced application efficiency and uneven crop yields under surface irrigation is undulations in soil surface, and consequent lack of uniform distribution of water in the field. This defect can largely be remedied by grading the surface to remove high and low spots. Further improvements can be effected by the use of large size land plains to reshape the whole field surface to uniform grade at optimum slope subject to top soil depth being adequate. This defect of non-uniform irrigation does not arise to the same extent where sprinkler irrigation is used. For carrying out levelling operation the depth of the cut and fill can be greatly reduced if the fields of individuals which lie across the contours (*i.e.* along the slopes) can, by consolidation of holdings (discussed under para 4.13-4.16 infra) be made to lie along the contours.

4.9. The water courses and field channels are a source of significant quantities of water loss. Due to poor maintenance, irregular alignments and larger wetted perimeters per unit volume of flow, the seepage opportunity from them is far greater than from the unlined main canals and branches. A kucha water course occupies a lot more (4 to 6 times) land than if a water

course is lined. Further, in the case of black cotton soils, due to alternate drying and wetting the banks of such earthen channels become weak and prone to breaches. In the circumstances, it will be desirable to provide a cheap and economical system of lining of water courses. Precast reinforced concrete slabs, troughs, half-rounds etc. with suitable leak-proof construction-cum-expansion joints need to be adopted. The water saved as a result of lining would decrease water costs per unit of crop yield and increase the irrigated area for a given outlet. Polythene pipes have been used with advantage for syphoning water out of such pucca water courses into the fields. They have the advantage of flexibility of off-take and avoidance of costly cross-structures.

4.10. The integrated land and water use design needs to provide an efficient excess water disposal system. The full components of such a system would be a main drain discharging into the streams or rivers, link drains and field drains. The system has to be designed to cater for the excess discharge that may be collected by it not only as a result of irrigation operations but also the excess run-off resulting from rainfall. Obviously, it will be too costly to design a system which carries away the water as it comes, especially during a storm, but it should be capable of draining the whole area within a certain number of hours to avoid damage to crops. In case of rise this period could be as long as three days.

4.11. Among the activities to be undertaken, one of the important ones concerns the training and clearing of natural nallahs. Usually, if not attended to, the natural drainage channels become choked with aquatic weeds. Therefore, the natural nallahs into which open field drains discharge need to be necessarily cleared and deepened and wherever necessary straightened out.

4.12. It will be desirable that the possibilities of providing supplementary irrigation from ground-water should be explored along with other programmes of land and water development. Two considerations command this line of action. Firstly, more often than not, the surface irrigation waters are hardly enough to cover the entire land for two crops and, depending on the location of the field *vis-a-vis* the outlet and the channel itself in which the outlet is located, the reliability of supplies is uncertain. This is particularly relevant in the case of diversion schemes not backed by surface storage reservoirs. Secondly, howsoever efficient irrigation practics may be, there is a residual downward movement

of water beyond the root zone and considerable quantities of water percolates through the soil to supplement the ground-water reservior. Theoretically, if an amount of water approximately equal to the long-term annual recharge is pumped it will provide control over waterlogging. Obviously, tubewells could be pumped at a greater rate during periods of shortfall in surface water supplies or in periods of extra demand. However, two important points to be borne in mind are that the details of water recharge is very difficult to assess in quantitative terms and that the ground-waters are highly viable in their suitability for irrigation due to dissolved minerals. Depending upon the total dissolved solid contents, the ground-water may be fit for being used directly for irrigation or, where salinity reaches moderate levels, it could be diluted with surface supplies. In some instances the salinity may be so high, with total dissolved solid content exceeding 3000 p.m., that ground-water may not be usable at all. Keeping in view the aforesaid, a judicious conjunctive use of surface and ground water irrigation facilities could be planned, which would help to optimise the benefits of the total land and water resources of the area. We may add that in certain States, underground water exploitation in canal irrigated areas is not permitted. In our view, such restrictions should be removed and the relevant administrative/legal orders should be rescinded.

Consolidation of Holdings

4.13. At present, one of the serious bottlenecks affecting agricultural planning and development is the excessive parcelisation of land holdings. In the size class of operational holdings between 2. 5-5 acres, on an average there are six parcels per holding, each of an average size of a little over one-half acre. Parcelisation of bigger holdings is all pervasive. It is estimated that in size range of 25—30 acres, there are as many as eight parcels. Over and above the fact that each holding is broken into too many parcels, these parcels in turn are so haphazardly laid out that, where irrigation is available, it is not capable of being used to the best advantage. The planning for land and water development as well as drainage and moisture conservation also gets vitiated in these circumstances.

4.14. At present, legislation for consolidation of holdings exists in most of the States except Orissa, Tamil Nadu and Kerala. However, progress in this regard has not been substantial except in three States, namely, Punjab, Haryana and U.P. Consequently,

for the country as a whole, only 361 lakh hectares have been consolidated. This constitutes about 20 per cent of the cropped area. A part from such inadequate crops even after consolidation, farmers have been generally left with about three or four disjointed parcels.

4.15. A major defect of the present process of consolidation has been that this programme has not been explicitly related to a rational land development and proper soil and water management. The only step taken in this connection has been in Punjab where a rectangular map of a village under consideration is passed on to the Irrigation Department for the alignment of water channels, fixation of outlets and alignment of main drains. The Irrigation Department was required to finish the job well in time so that the consolidation staff could keep it in view. In other States such as U.P., even these aspects have been generally missing.

4.16. In the integrated development projects that we are visualising, consolidation of holdings is an important part of the programme. At the same time, since various lands are subjected to land improvement and made homogeneous in character, it is contemplated that, at the end of the operation, the lands of each farmer will be in one single place and will have uniformity of access to water channels, drainage and farm roads.

Crop Planning and Agricultural Extension

4.17. Since the various land and water development programmes identified above involve considerable financial outlay, it is necessary that the developed land is put to optimum use. This is essential both for increassing the production as also for enabling the farmers to discharge the financial liability that they would have contracted. Intensive extension work, in this context, will necessarily be an essential element.

4.18. One of the major efforts required will be concerned with the evolution and propagation of appropriate cropping pattern. This would require adaptive research in the form of field varification trials. Hence in each integrated development project, a centre for adaptive research may have to be organised in each district selected for the project. Agricultural scientists drawn from various disciplines like agronomy plant protection, soil and water management, agricultural machinery etc. must be on its staff. Such a centre will have to be backed up with a massive programme of demonstration and training of farmers

in the scientific techniques of cultivation. The on-going Plan schemes and programmes relating to these aspects must be devotailed with similar activities under the project.

Development of Infra-structure

4.19. In the integrated development projects, it is self-evident that development of infra-structure covering items such as communications and road, agricultural credit institutions, facilities for marketing processing and storage will be vital. In designing for the development of infra-structure, it will be necessary to identify what are called Growth Centres *i.e.,* small or intermediate size towns that have a high capacity for growth. Under the Fourth Plan, the methodology for identification of such growth centres has been sought to be evolved under a Centrally Sponsored scheme for pilot projects for Growth Centres. Broadly speaking, a Growth Centre is expected to provide for the following :

(a) Banking and Postal facilities

(b) Agro-services

(c) Retail Depots for Input supply

(d) Facilities for marketing of Farm Produce Marketing yards

(e) Storage and Warehousing Facilities

(f) Vocational Training Centre

(g) Information Centres

(h) Shopping Centre

(i) Local Administrative Office, wherever feasible.

(j) Veterinary Dispensary.

Without these Growth Centres and efficient marketing and storage systems, strangulation points will soon begin to appear. Thus, building up of an efficient infra-structure should proceed, at least proceed simultaneously with the construction of an agri-cultural area development plan.

Development of Small Farmer and Agricultural Labour

4.20. As pointed out earlier (*Vide* para 2.3), one of the pre-eminent objectives of integrated rural development is that the development promoted in the defined area should be as broad-based as possible so that the large mass of the rural people, particularly, the small farmers, marginal farmers, agricultural labourers are enable to participate in development and share the benefits of such development. At present, a certain number of projects started under the Fourth Five Year Plan are in operation in different parts of the country for this very purpose. The working of these projects have been going on for a limited period and it is not easy to draw very firm lessons from the experience available so far. However, it will be necessary to build into the programme of integrated development some of the features of the SFDA and MFAL projects which have been found to be useful. By way of illustration, one might mention the device for enabling larger flow of credit to small farmers by providing a special risk fund to cooperative credit institutions. Another illustration concerns development of minor irrigation works on group basis through a provision of joint loans from credit institutions coupled with subsidy from Government.

Legislative and Administrative Framework

4.21. It would be seen that the integrated rural area development project visualised in this report will embrace a large variety of activities in terms of the present set-up in various States, the following Departments/Organisation are likely to be concerned with one or more of the following programmes :

(i) State Soil Conservation Organisation/Department;

(ii) Revenue Department (in respect of consolidation of holdings);

(iii) Irrigation Department (in respect of construction of drains/water courses);

(iv) Agriculture Department (in respect of crop planning, agricultural extension etc.);

(v) Cooperative Department (in respect of marketing, processing and storage infra-structure);

(vi) SFDA/MFAL agencies; and

(vii) Credit Institution.

4.22. Among the existing State laws, the following legislations are likely to be relevant to the programmes visualised above :

(i) Irrigation & Drainage Act.

(ii) Soil and Water Conservation Act or Land Improvement Act.

(iii) Consolidation of Holdings Act.

4.23. Among the items and soil and water conservation schemes which can be provided specifically and are usually visualised under the Soil and Water Conservation Act are the following :

(i) Measures against wind erosion and water erosion (sheet erosion, gully and ravine formation, bank cutting and floods), such as :

(a) construction and maintenance of 'mends', 'duals' and 'bundhis' and planning of munja, sarkanda or other soil binding grasses or plants thereon;

(b) levelling of the land, grading and irrigation layouts;

(c) contour cultivation;

(d) prohibition on growing row crops;

(e) strip cropping;

(f) growing of quick-maturing leguminous crops and close growing crops during rainy seasons;

(g) green manuring and application of bulky organic manures, etc., compost farm-yard manures etc.;

(h) retirement of any land from cultivation if its continuance under cultivation is prejudicial to this land or some other land;

(i) control of grazing;

(j) afforestation or planting of fruit trees or raising of pastures on any land for its protection from erosion or for the protection of any other land;

(k) planting of trees or shrubs to serve as wind-breaks;

(l) control of the felling or lopping of trees or clearance of bushes;

(m) prevention from breaking of marginal and sub-marginal lands including "Charnet" for cultivation purposes;

(n) maintenance of surface mulches; and

(o) adoption of suitable crop rotations.

(ii) Measures against water-logging and impeded drainage, such as:

(a) drainage of water-logged area to make them fit for cultivation;

(b) conversion of water-logged area into ponds where drainage under clause (a) cannot be economically done;

(c) opening of drainage cuts;

(d) pumping out the sub-soil water; and

(e) increasing the number of culverts and aqueducts or widening the existing ones along railways, canals or road embankments.

(iii) Measures for improving sandy soils, such as:

(a) construction of 'mends', 'duals' or 'bundhis' and planting munja, sarkanda or any other soil binding grasses thereon;

(b) levelling of land in irrigated areas;

(c) prohibition of cultivation of sand dunes;

(d) growing of leguinous crops;

(e) application of bulky organic manures, e.g., compost farm-yard manures etc.;

(f) maintenance of surface mulches;

(g) control grazing;

(h) creation of wind-breaks along canals, roads, railway tracks, fields and other places wherever it is considered necessary for the purpose of checking the drafting sand; and

(i) adoption of suitable crop rotations.

(iv) Measures for prevention of usar formulation and reclamation of usar lands, such as :

(a) drainage of both surface soil and sub-soil where the water-table is high;

(b) construction of bundhis and impounding of rain and canal water in places where the water-table is low with a view to washing down the injurious salts;

(c) providing drainage cuts where there is water-logging;

(d) application of gypsum and such other correctives.

4.24. As regards the Irrigation and Drainage Act, the legislation usually provides for powers to construct and maintain water courses and recover the cost thereof. Procedure is also prescribed for preparation of schemes for drainage works and for recovery of cost thereof from the cultivators.

4.25. For the integrated agricultural development projects that we are visualising, it is obvious that a special project authority will have to be set up. Various alternatives are possible. It may be a project authority created and designated by an executive order of the State Government, an alternative would be to set up a corporate body under the Societies Registration Act. Another alternative would be to create a corporate body under the Companies Law. Finally, the integrated area development corporation could be created by a special law enacted by State Legislature.

4.26. In making a choice out of these alternatives, the following relevant considerations need to be kept in view:

(i) The project authority may have to carry out various land and water development works by invoking existing or new legislation governing activities such as soil and water conservation, consolidation of holdings etc. Hence the project authority should be of a type that it is able to command a *locus standi* in such enactments by virtue of suitable amendments to be made in this regard;

(ii) The project authority may have to incur expenditure on land and water development from its own funds and later on recover the cost from beneficiaries over a stipulated period. In such an event the authority should

be enabled to attract institutional credit from commercial banks who may be able to get refinance from ARC.

(iii) The kind of manpower that would be required by the project authority will cut across various State Departments and hence it may now be possible to place the project under one designated Department or the other.

4.27. In view of the above considerations, it seems that the balance of advantage might lie in creating a project authority which has eventually a statutory basis but which may initially be set up as a corporation under the Company Law. However such a Corporation must be interlocked with the agricultural development administration of the district. Hence the district collector should be the Chairman of the Corporation as the relevant officers of Agriculture, Animal Husbandry, Dairying, Cooperation, Irrigation, etc., might be acting on the board of directors.

Economics of Integrated Land and Water Development

4.28. Before concluding this Chapter, we may also refer to a relevant aspect, namely, the economics of the proposed type of integrated land and water treatment from the point of view of the beneficiary farmers. In this connection, a certain amount of practical experience is already available. We cannot do better than merely enclose a paper prepared by Mr. D.A. Sims, Technical Officer, UNDP, Chambal Land and Water Use and Management Project. He prepared this paper for a Workshop on Soil and Water Management held in March 1971. This paper gives the technical specifications of the land development plan. It also contains, *inter alia,* details about the costs and benefits to the farmers from the proposed type of land and water development works.

CHAPTER V

LOCATION AND FINANCING OF PILOT PROJECTS

Location of Pilot Projects

5.1. While there are immense possibilities for implementation of integrated development projects in canal irrigated areas all over the country, it is necessary to make a careful and selective beginning. We would suggest that, to begin with, 11 pilot projects may be taken up. These may be located in suitable districts which fall within the command of selected major irrigation projects. The districts chosen should be such that these are characterised by a significant lack of optimum utilisation of available water and land resources.

5.2. In the light of the above criteria, the following districts are suggested for the pilot projects :

(1) Midnapur District (West Bengal)

Midnapur District falls within the command of Kangsabati Irrigation Project. The Kangsabati Project envisaged construction of dam across the river Kangsabati and Kumari in Bankura district of West Bengal, to irrigate 3,84,465 hectares in Bankura and Midnapur districts. The Kangsabati Dam has been completed in 1965 and the Kumari Dam is expected to be completed in 1973-74. A potential of 1.3 lakh hectares has been created by end of 1971-72 and this would increase to 2.63 lakh hectares by the end of the Fourth Plan. The command area will need development, for achieving the maximum benefit possible specially with regard to land levelling and shaping, consolidation, field channels drainage, proper cropping pattern according to soil, and development of shallow tubewells. Rural roads and marketing, etc. would also need attention.

(2) Sambalpur District (Orissa)

The Hirakud Project envisaged construction of a dam across Mahanadi river in Sambalpur district, Orissa, to store 8,100 million

cubic meters of water for irrigation of 6 lakh acres in Sambalpur district. The dam has been completed in 1957. The utilisation by the end of the year 1969 was reported to be 5.7 lakh acres. The utilisation of the potential created has been lagging behind due to lack of command area development including field channel construction. There is scope for full utilisation of the potential and improving the efficiency by development of the command.

(3) Bundi District (Rajasthan)

This district is served by Chambal Project. Chambal Project consists of 3 reservoirs, namely, Gandhi Sagar, Rana Pratap Sagar and Jawahar Sagar, and one barrage at Kotah on river Chambal. The ultimate irrigation potential envisaged is 2.35 lakh hectares. Against a potential of 1.74 lakh hectares created upto 1971-72, the utilisations is 1.58 lakh hectares. The command area of this project lies in Kotah and Bundi districts of Rajasthan Within a short time of the introduction of canal irrigation, several problems like rising ground water table increase in solid salinity, infestation of canals with equatic weeds, arose in the command area. These problems have not only adversely affected the utilisation of irrigation potential but also resulted in low overall increase in agricultural production. There is need for land development including consolidation of holdings, construction of lined channels and field drainage for efficient and speedy use of the potential created and to prevent water-logging. Proper regulation of water supplies and night irrigation also need special attention.

(4) Bhind District (Madhya Pradesh)

The command area of Chambal Project in M.P. lies in Bhind and Morena districts. The irrigability survey of the soil has already been completed. Irrigation from the Chambal Project started in 1961-62. Against the ultimate irrigation potential of 2.83 lakh hectares (now reported to be only 2.0 lakh hectares) the potential developed upto 1971-72 was reported as 2.73 lakh hectares out of which the utilisation has been only 1.21 lakh hectares. With the introduction of irrigation the ground water table in certain areas has perceptibly risen. This as well as the poor utilisation of irrigation potential is attributed to improper soil and water management in the command area, *i.e.* land shaping, water courses and field channels, field drainage and main drainage, etc.

(5) Gorakhpur District (U.P.)

This district falls under the command of Gandak Project. Gandak Project is an inter-State Irrigation Project with the association of Bihar and consist of a barrage, a power-house and network of canal. The western main canal in U.P. is about 110 km. long. That would irrigate 3.1 lakh hectares in Gorakhpur and Deoria Districts of Eastern U.P. The project started in 1961 is expected to be completed substantially by the end of Fourth Plan. A potential of 65,000 hectares have been created by 1971-72 against which a utilisation of 32,000 hectares is anticipated. For efficient use of the potential created soil and water management practices will have to be demonstrated and an area programme for command development has to be undertaken. Drainage and consolidation of holdings would need special attention. Roads and marketing also need attention.

(6) Raichur District (Mysore)

Tungabhadra project to service the drought affected section of Mysore and Andhra Pradesh was planned as a protective system of irrigation for as large areas as possible. It has a dam and reservoir of capacity of 3 million acre feet to irrigate about 12 lakh acres of land. It is served by 3 major canals; the Left Bank Canal with a head discharge capacity of 3100 cusecs to irrigate. 5,80,000 acres in Raichur district of which 8% is localised as perennial, 10% as wet and 82 per cent as light and dry-cum-wet. The corresponding figures for Right Bank low level canal of 2,500 cusecs discharge are 16 per cent, 10 per cent and 74 per cent respectively while the third, *i.e.* Right Bank High Level Canal with a head discharge of 4000 cusecs is entirely localised as dry-cum-wet for 4,50,000 acres to be irrigated from July to November. The distribution system in the Right Bank H.L.C. is, however, not yet fully developed. Considerable development with reference to the irrigation potential created remains to be achieved, chiefly under the command of the Left Bank Canal and Right Bank H.L.C. The main factors of under-utilisation of the irrigation potential are low discharge in canals, high duty factor assumed for different crops, slow development of land, unauthorised use of water in the non-localised areas and over use in the localised areas, large size holding, inadequate credit and marketing facilities, considerable waterlogging and drainage problems on the left bank, etc.

(7) **Muzaffarpur District (Bihar)**

The Gandak Project consists of a barrage and a network of canals designed to irrigate 11.5 lakh hectares in the four districts of Saran, Champaran, Muzaffarpur and Darbhanga of Bihar. Construction work on the project which was started in 1960 and the barrage and some portion of the canal system have been completed and the rest is in progress. The full development of irrigation potential is planned to be achieved by end of Fifth Plan. Out of 2.0 lakh hectares potential created upto the end of 1971-72, only 0.6 lakh hectares is being utilised. Irrigation potential has not been fully exploited due to slow development of land and its shaping and field channels and drainage, lack of adequate main drainage, fragmented holdings, poor communications, and marketing facilities etc. The "satta" system of irrigation prevalent at present also needs to be changed.

(8) **Calicut District (Kerala)**

Kuttiyadi Irrigation Project in Calicut district of Kerala envisages construction of a masonry dam across Kuttiyadi river to irrigate 31,000 hectares in Calicut district. The commanded area constitute the coastal area with deep alluvial soil, the low land with deep sandy loan and clay soils and as well as the rolling land higher up with laterite soils. All these soils are suitable for irrigated cropping. The rainfall in the command area is about 2500 mm. mostly in the monsoon period. The crops grown are paddy and garden crops of coconut, arecanut, etc. Good progress has been made on the project and would have been substantially completed by the end of the Fourth Plan and would also start giving the benefits. In order to get the maximum benefits, it would be necessary to pay attention to land sharing, field channels, drainage, rural roads, marketing and storage, etc.

(9) **Jalgaon District (Maharashtra)**

Girna Project envisages masonry dam across river Girna and a main canal of 144 km. The work on the scheme was started in 1958 and the project has been practically completed. It would provide irrigation potential of 57,000 hectares in 1973-74. A potential of 48,000 hectares has been created so far. The utilisation by end of the Fourth Plan is expected to be 40,000 hectares. To get the maximum benefits from these irrigation facilities, it is necessary to devote attention to land levelling

and shaping, consolidation of holdings, field channels and field drainage, and main drainage to prevent water-logging and salinity. rural roads and marketing facilities would also need attention.

(10) **Jammu District (Jammu and Kashmir)**

Tawi lift irrigation project envisages construction of 20 miles long lined canal with water pumped from river Tawi near Baghu port in Jammu Division of J. & K. State. The scheme was sanctioned in 1969. The irrigation potential proposed is 13,000 heetares with the pumped discharge of 300 cusecs. The command area has a rainfall varying from 800 mm. to 1500 mm. The water table level lies between 5.75 ft. to 24.00 ft. below the ground level. The command area needs to be developed with land shaping and levelling, construction of water courses and field channels as well as field drainage for effective utilisation of the irrigation potential. A potential of 10,000 hectares is expected to be created by 1972-73 with the ultimate potential of 13,000 hectares.

(11) **Guntur District (Andhra Pradesh)**

Guntur District is one of the districts of coastal region of the Andhra Pradesh which falls within the Command of Nagarjunasagar Project (Right Bank Canal). The Nagarjunasagar Project envisaged construction of storage dam across river Krishna which stands completed and two canals, one on Right side, length 127 miles (203 KM) and another left bank canal of 111 miles length (178 K.M.) to irrigate 11.74 lakh acres (4.76 lakh hectares) on the right bank canal and 8.80 lakh acres (3.56 lakh hectares) on the left bank canal. The project will benefit Kurnool, Nalgonda, Khamman, Nellore and Guntur districts of the State. The works on the right bank canal have been completed in length of 91 km. which approximately accounts for 66 per cent. The works on the Left Bank Canal have been completed in a length of 115 km. The earth work completed nearly accounts for 91 per cent.

The entire project is expected to be completed in the Fifth Five Year Plan. Against the ultimate potential of 8.32 lakh hectares, potential of 4.13 lakhs hectares was expected to be developed by 1971-72. This is expected to increase to 4.42 lakh hectares by 1973-74. The utilisation up to 1971-72 was 3.95 lakh hectares which is expected to rise to 4.00 lakh hectares by 1973-74.

In order to utilise the potential developed speedily and efficiently, soil and water management practices will have to be demonstrated and an area programme for Command Development has to be undertaken. Field channels, roads, marketing, drainage, consolidation of holdings etc. would need attention.

5.3. In each of the selected districts, command areas of a number of minors should be identified preferably in different parts of the district. Each of these command areas will have to be taken up for integrated rural development broadly on the lines indicated in Chapter IV. It should be the objective to take up, in selected districts, a cluster of commands so that in the first or the second year of the project, something like 4,000 hectares are brought within the purview of integrated land and water treatment. As the effect of demonstration spreads, more areas can be taken up so that in a period of about three years or so, a sizeable proportion of the cropped area of the district can be brought within the various elements comprising integrated rural development.

Financing of Pilot Projects

5.4. A large number of items are envisaged as part of the integrated development project. Some of these items are at present financed under the various on-going schemes. Broadly speaking, the following could be considered as the mode of financing some of the major elements:

(i) Technical and servicing staff and the expenditure connected therewith may be met entirely by Government. This should be an outright expenditure to be incurred by the proposed Integrated Rural Development Corporations.

(ii) There are certain common items concerned with construction of main drains and/or training of nallahs whose cost may also be met entirely by Government and for this purpose, project funds may be utilised.

(iii) For items such as land levelling, provision of water courses and field drains, the cost should eventually fall on the beneficiary farmers and may be financed by way of long-term credit. For this purpose, the farmers, wherever possible, may obtain direct credit from institutional agencies such as commercial banks/land development banks. In certain other cases, it should

be possible for the Corporations to undertake the works and recover the amount from the farmers over a number of years. The Corporations may, in turn, seek finance from institutional sources.

(iv) The programme of rural works to be undertaken under the crash scheme for rural employment may be adjusted, wherever possible, so that part of the expenditure required on complementary public works may be met out of the funds provided under the scheme.

5.5. The funds of each Corporation conceived for individual pilot project may be derived in the followinng manner:

(i) Grant given by the Government of India:

(ii) Contribution to share capital by Government of India;

(iii) Contribution to share capital by State Government; and

(iv) Loans raised from institutional sources particularly Commercial banks.

5.6. In the initial stages, particularly during the remaining period of Fourth Plan, the Government of India alone may agree to provide a grant of Rs. 1 crore to each Corporation. In addition we suggest that the Government of India may contribute to the share capital of the Corporation. This contribution may be spread over a period of 3 years. The size of the contribution may vary from Rs. 2 to Rs. 4 crores depending upon the scope and extent of operations envisaged in each project area. The specific details in this regard may be worked out by the Ministry of Agriculture through the State Governments who will have to prepare a detailed master plan for each project in the light of the general guidelines indicated by us in the proceeding chapter. A bench mark survey will from part of the exercise.

ANNEXURE

Paper prepared by Mr. D.A. Sims, Technical Officer, UNDP, Chambal Land and Water Use and Management Project for the Workshop on Soil and Water Management at Ranchi, Bihar, March 1971

There is a general need for an irrigation and soil conservation system, or pattern of land use, the basic design of which is standardized and can be easily understood by officials and farmers, and widely applied. This paper describes a land use pattern developed by the UNDP Chambal Land & Water Use and Management Project working on the Chambal Irrigation Scheme in Rajasthan.

Features Required in a Land Development Plan

(1) It must comprise an integrated scheme which includes water distribution land levelling, drainage, and access roads, and must be capable of being applied to all the land in a watershed or irrigation command.

(2) It must be capable of being applied to all topographical, soil, and other conditions without alteration of the principles and concepts which underlie it, by design staff who may not fully understand or be fully aware of these principles.

(3) For similar reasons, it must employ lengths, widths, distances, slope and structures which have a fixed relationship with each other.

(4) It should, whether applied under dry farming or irrigation condition protect the land against erosion and at the same time ensure proper drainage.

(5) It should give each farmer control of his own water supply and his own drainage outlet, and should provide him with access to his land without passing through the fields of other cultivators.

(6) It should cater for all crops likely to be grown in the area, and consequently suit different methods of irrigation within the field. (furr border strip, flood irrigation, etc.).

(7) It should allow mechanised farming to be practiced or introduced.

(8) It must embody sound agronomic principles, encourage better practices, and he as cheap as possible to instal.

Several variations of soil conservation and field irrigation systems are in use or are being applied by the Government agencies, but none includes all the requirements listed above. In many cases field access is not given, safe and adequate drainage is not provided for the system, and mechanised agriculture may not be possible. Designing is a lengthy process done on an individual field, or more rarely, individual property basis and staff with the necessary experience and breadth of knowledge are in short supply.

The UNDP Chambal Project has developed a system which seems to combine the requirements which have been listed, and has applied it to two hundred acres of farmers' land at Digod village, near Kota, as a demonstration.

The Basic Design

The design which has been chosen is a modified contour strip system used in conjunction with down the slope supply channels and drains.

The simple unit of irrigation consists of a lined supply channel and a collector drain; the supply channel being on a ridge, with the drain in the intervening depression. Roughly rectangular fields, having a slight longitudinal slope, receive water from the channel at their higher ends and drain, through protected outlets into the open ditch which runs along the lower boundary. The fields, having a slight longitudinal slope, receive water from the aligned almost on the natural contour. These form the legal plot boundaries.

Spoil from the excavation of the drain is used to form as access and service road along one of its banks. Another service road runs on the further side of the watercourse. The source of material for this road on the further side of the watercourse. The

source of material for this road varies according to whether an existing Minor canal is being lined or if the watercourse is being newly constructed. Access to all the fields can be had from one or other of the two roads or tracks. Suitable control, outlet, and crossing structures are used in the distribution and drainage system where necessary.

Provided that all design criteria are laid down and fixed in relation to the natural conditions of the site, multiples of the basic unit be used to cover a whole watershed or command, and can be applied to very wide range of conditions. The aim has been to evolve a system, not design for a single individual area. The system provides every farmer his own controlled water supply and his own drainage outlet. No one is forced to accept drainage from another's land, and all have road access to their fields.

The layout, when it is used to cover a complete watershed, is a contour grid which, apart from promoting efficient irrigation, has obvious advantages in making the most use of available rainfall while at the same time preventing erosion.

Design Criteria

1. *Watercourses*

The slopes and cross sections of the water courses and drains depend on the area of land to be served, and on the flow characteristics of the materials used in construction. In the Chambal area, one to four cusec concrete lined watercourses are used. In some cases an existing earth Minor canal is lined, and in others an entirely new channel has to be constructed.

In the case of the existing Minor, the required slope and cross section is calculated and the necessary excavation carried out in the top of one of the existing, already consolidated earth banks. This is usually done with a hydraulically controlled excavator fitted with a "V" bucket, and then trimmed where necessary by hand. The sloping sides of the trench are then lined with two inches of damp sand to which Bentonite has been added. Two inches of un-reinforced concrete are then placed and shaped by hand, without the use of any frame-work. Four masons, supported by the mixing crew, can construct 60 m. (200 ft.) per day. Joints are left at every 3 m. (10 ft.), and are later sealed with bitumen and plastered over. The sand cushion is necessary because of the high clay content of the soil, which can expand

and contract by up to 25 per cent by volume on wetting and drying. The other bank of the Minor is levelled to form an access and service road, and the original borrow pits on each side filled up in the course of grading the adjoining fields. The new watercourses serve contour strips on both its sides, and together with its service track, occupies only half the width previously taken up by the unlined Minor and associated borrow pits.

In the case of a completely new watercourse the necessary consolidated earth bank has first to be formed. This is done at the same time as the fields on each side are being graded, by carting subsoil from trenches excavated in higher portions, in small scrapers or tipping trailers. The moist clay soil is laid in layers and is sufficiently consolidated by the vehicle wheels continuously using the partly formed bank as a haul road. The subsequent excavation and lining is done in the same way as and when improving Minors.

Drop structures have to be made when the slope of the land conflicts with the necessity to provide a minimum of six inches of head for irrigation of the adjacent fields. Initially, one cusec outlets were provided, one for each four fields, but has now been possible to persuade farmers to use rubber and plastic syphons, and no outlets are required. This is no cheaper, but does avoid the constant leakage.

2. *Contour Fields*

The main crops of the area are Sorghum (Jowar) which occupied more than 90 per cent of the total cultivated area during the summer cropping season, and Wheat (74 per cent during the winter season). Maize, beans, chillies, linseed, and other crops are also grown. Rice cultivation was introduced a few years ago, and the acreage sown is increasing very fast, so that the field design has to cater for both flow and flood systems of irrigation.

Because of the very low infiltration rates (around 1 mm. per hour) minimum grades had to be used on the terraces, but some slope is essential, since water must drain off, particularly during the monsoon, when high intensity storms are common. During this time of year (because of the soil and rainfall factors together) crops are often adversely affected by standing water in the fields. Taking all known facts into consideration, the maximum length of a terrace has been fixed at 200 m. and longitudinal slopes are allowed to vary between 0.05 per cent and

0.1 per cent. The contour interval between terraces is 10 cm. giving a 30 m. (100 ft.) width when the natural slope of the area is 0.3 per cent. Thus the terrace is such a size (0.6 ha.) that it can be cultivated mechanically, can be irrigated with a one cusec flow of water, and is suitable for any form of irrigation. A cross slope (the same grade as the longitudinal slope) is also given, so that drainage is automatic and furrow irrigation can be carried out across the field, but the width and slope are such that when flooded (by the use of temporary cross checks) for rice, the difference in water level across the width is only 3 cm. (1.8 ins.). The bunds which divide one field from another are permanent and grass covered. They form the property boundary and are made 50 cms. (20 ins.) wide at the top, which is 30 cms. (12 ins.) above the level of the higher terrace.

3. *Drains*

Two types are used, termed deep drains and surface drains. The deep drain is 1.5 to 2.5 m. deep (5 to 8 ft.) and usually cuts through the clay oil and taps the more prous subsoil layer where groundwater is under pressure, the clay being a confining layer. Deep drains are used in conjunction with subsurface drainage systems comprising deep subsoiling (60 cm. or 2 ft.) and either mole, pipe, or tile drains. Where salinity or waterlogging are not problems, surface drains are used. These are 1.3 (4.25 ft.) or less in depth.

Both types of drain are made with a hydraulic, track type excavator. Bottom width is 0.3 m. (1 ft.) and side slopes are at 1.5 to 1. (Slumping takes place if any lesser slope is used), and are turfed to prevent crop Bed Slopes are kept as great as possible consistent with the avoidance of erosion, to delay or prevent the establishment of reeds (mainly Typha sp.) which are otherwise quick to choke drains or unlined watercourses.

The open field drains described above discharge into nalas which are the natural drainage system of the area. These in their turn may have to be improved by cleaning, desilting and training by dragline or excavator.

Land Consolidation, Realignment of Boundaries

It has been stated that terrace boundaries, which run almost along contours, are legal plot boundaries. Most farmers own one or more terraces, but where division of terraces is done, it is done along not across.

In Digod village, where the demonstration was carried out, cultivators were persuaded to allow complete reorganisation of land boundaries. One hundred per cent of the land in the demonstration was treated and reallocated, as far as possible in the same place as before, after treatment. Only one crop was lost. Boundary realignment is necessary for the success of the scheme. It is possible to achieve and is well worth striving for. Once done it is very much appreciated by the farmers.

The new system occupies less space than the old, and in addition, uncommanded patches, reed covered areas, borrow pits, old nalas, etc., come under cultivation. It was round that there is a total gain of 10 to 20 per cent of cultivated land whose value must be set against the cost of the work.

Design and Implementation

The steps to be taken in designing a layout for any particular area have been simplified and systematised, so that though sub-areas may be done by different people, it will not be noticeable where one left off and the other began.

The procedure has been written down in detail[1] but is too long to reproduce here. Briefly, it consists of (1) identification of suitable ridge and depression lines on the contour map (1 : 10,000 scale) and definition of the direction and rough position of the terraces. (2) Transference of part of this rough outline to a 1 : 1,000 map, and detailed design work, where every effort is made to reduce the lead and the cut of soil. Cost and level calculations can be carried out, but in land grading work, civil engineering methods of cost calculation based on volume of earth moved do not give accurate results. The most accurate estimates are those worked out on a per hectare basis, from previous experience, making allowance for any change in working conditions (change in slope or unevenness of ground, particularly wet working conditions, etc.).

A two part method of charging is now being worked out by the Project. Part A is the cost of common services, (water distribution, drainage, structure, and access tracks) which is divided evenly per hectare served Part B is the land levelling cost, which varies according to the class of land. Accurate classification for land levelling purposes must wait until more experience is gained, but a preliminary three class system has been drawn up and will probably be further subdivided later.

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[1] Part D, Appendix IV Technical Report. Agricultural/Engineering UNDP Chambal Project.

Costs depend very greatly on machine management on the field, and consequently on the experience of the field engineer in charge.

The survey methods used in levelling the terraces, the most suitable combinations of machinery, and the best methods of using them have been found out by experience.

A well balanced group of machines can consist of three bulldozers (7 ft. blade), one mechanical excavator, a motor grader, four agricultural tractors with tipping trailers, one land plane, (40 ft.) and a disc plough. It is also a great advantage to have a ripper or set of giant discs to fit behind the bulldozers.

The staff requirements will be two Junior Engineers, one Surveyor and several Chairmen, two Mistries or Foremen, four Masons, and fifteen or twenty labourers, apart from the drivers and maintenance staff for the machines.

Rate of Progress

Under the conditions in the Chambal Commanded Area, the team described above should be able to complete 20 hectares of the complete system per month. The rate will vary from a lower limit of about 10 hectares per month in boggy conditions or where there are many nalas to be straightened, to 30 or more hectares per month under best conditions.

Costs for a Sample Area

Total area : 400 hectares (not including main drainage nalas)

	Length	Per cent of total area	Unit cost	Cost Per hectare
			Rs.	Rs.
Length of improved Minor canal	3,160 m.	0.8%	40/m.	320
Length of water course (now)	9,765 m.	1.61	30/m.	750
Length of shallow drain	11,200 m.	0.95	7/m.	
Length of deep drain	3,250 m.	2.08	13/m.	
Length of main drainage nala to clean	4,000 m.	N/A	2.6/m.	330
Cost of Structures	N/A	N/A	400/ha	400
Cost of land grading	N/A		2000/ha	1500
	Total :	4.9%	—	3,000

(Rs. 1, 330/acre)

Both machine and labour costs are included in the above figures. Machine cost are based on calculations which include depreciation, insurance, repairs, maintenance, and all running costs. The cost of land grading has been given as Rs. 2,000 per hectare, but in practice this varies between Rs. 1,000 and Rs. 3,000 depending on the class of land, whether Class I, II, or III.

The total figure may seem high, but it should be remembered that this is not simply a land levelling operation, but a complete development of an area in the field of irrigation, drainage, conservation, and access. Maintenance costs are low, and the stage is set for improved agricultural technology if the necessary knowledge is imparted to the farming population by the Agricultural Extension Services.

It is worth noting that since the original 80 hectares (200 acres) demonstration was carried out, farmers in the adjoining 96 hectares area have agreed to have the same work carried out on their land at their own cost. Preparatory work is now going on.

Some Observation on the Returns to be Expected

	Local average irrigated yield	Value of produce	Cost of production	Profit per hectare
		Rs.	Rs.	Rs.
Wheat	2,000 kg/ha	0.80/kg	600	1,000
Rice	2,500	0.55/kg	750	750
Jowar	900	0.60/kg	435	20
Total profit for the two crop year:				Rs. 1,770

Thus taking rice in the Kharif and wheat in the following Rabi season, a farmer could expect to pay off his investment within a reasonable period. The figures given above do not pretend to be accurate or exact. They are intended only to give a rough illustration. If the standrad of agro-technology and the scale of inputs were increased to match the potential provided by the system described in this paper, yields could be more than double the figures given above.

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